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State of the Art of Wind Farm Optimization

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Abstract

The present work attempts to outline the state of the art in the field of wind farm layout optimization. To do so the literature of the last two decades has been analyzed and the common structure of the problem has been defined. The most effective techniques and models are described. The usual pitfalls are as well listed, whose aim is the creation of a blueprint for future development of wind farm optimization tools/softwares. The last point touched by this work highlights the areas where a better understanding is needed and more research should be addressed to determine realistic layouts.

Objectives

Creating a tidy knowledge base and defining a common structure for future development of wind farm optimization tools/softwares.

Methods

Clear definition of the layout optimization problem which is made of two components:

► **definition of the objective function**, or the criterion that the wind farm has to meet to be considered optimal. The most commonly used functions in literature are **ENERGY YIELD, COST OF ENERGY AND PROFIT** or **FINANCIAL BALANCE,**

► **definition of a wake model,** to asses the energy yield,

► **definition and assessment of ALL the costs that depend on the wind farm topology: ELECTIRCAL GRID, INFRASTRUCTURE, INVESTMENT, DEGRADATION,**

► **definition of the optimization strategy:**

► **ONE STEP OPTMIZATION: genetic algorithm, particle swarm, Montecarlo.**

► **TWO STEPS OPTMIZATIONS,** needed for heavy objective functions. Usually a combination of meta-heuristic and a local search algorithm (**gradient based, linear programming, greedy heuristic** e.g.**).**

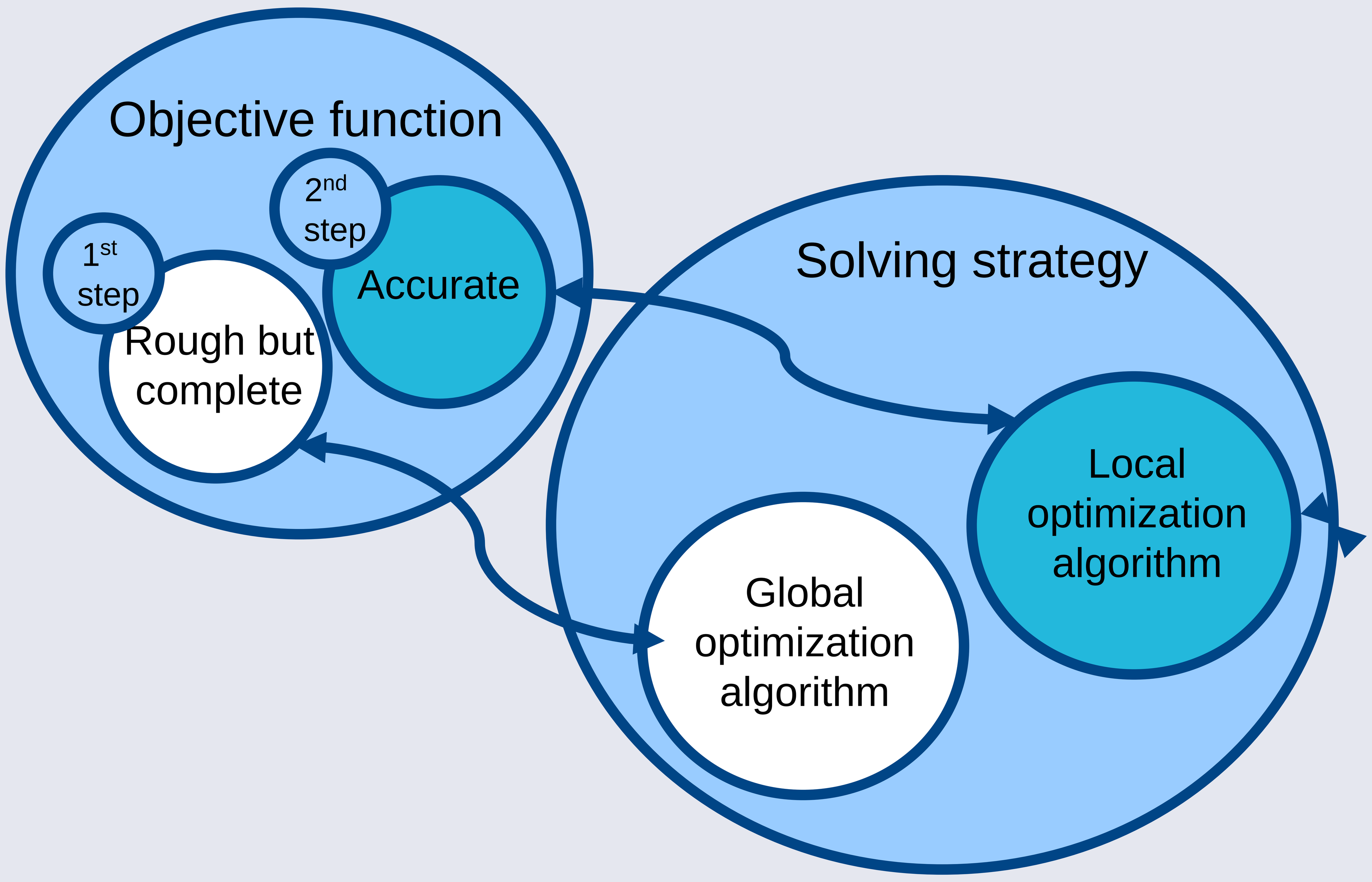
Results

The main findings concern:

► The **high dependency of the resulting layout on the objective function**, which, for practical purposes should be the most accurate possible. and not only the energy yield.

► As a consequence the **cost functions need always to be modeled** and assessed, which in turn raises the complexity of the objective and the computational time, yielding to nested optimizations.

► **The rise in complexity creates the need for a optimization strategy**, a **combination of two algorithms** is currently used in the state-of-the-art research tools, instead of one, as used at the wind farm optimization infancy.



Conclusions

The next steps should be:

► **set-up of a benchmark case** to test new objective functions and/or compare performances of different methods,

► **refinement of cost models**, degradation cost, e.g., because of the dependency of the solution on them,

► **development of new specific searching algorithm,** based on the properties of the problem, instead of the natural-inspired algorithms.

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